

## **EXHIBIT 20**

IN THE UNITED STATES DISTRICT COURT  
WESTERN DISTRICT OF TEXAS  
WACO DIVISION

NEONODE SMARTPHONE LLC, §  
§  
Plaintiff, §  
v. § Civil No. 6:20-cv-00507-ADA  
§  
SAMSUNG ELECTRONICS CO. LTD, and §  
SAMSUNG ELECTRONICS AMERICA, §  
INC., § **JURY TRIAL DEMANDED**  
Defendants. §

**SUPPLEMENTAL DECLARATION OF ANDY COCKBURN IN SUPPORT OF  
DEFENDANTS' REPLY CLAIM CONSTRUCTION BRIEF**

I, Andy Cockburn, hereby declare as follows:

1. I submitted an expert declaration on claim construction of U.S. Patent No.

8,095,879 (“the ’879 patent”) on April 14, 2023 (Declaration of Andy Cockburn in Support of Defendants’ Opening Claim Construction Brief, or “Opening Decl.”) at the request of counsel for Defendants Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. in the above-captioned case (“Defendants”).

2. I was asked to consider and respond to opinions set forth in the Declaration of Craig Rosenberg in Support of Plaintiff’s Opening Claim Construction Brief (“Resp. Br. Ex. 24”), dated May 19, 2023, regarding claim construction of the ’879 patent. I have also reviewed Neonode Smartphone LLC’s Responsive Claim Construction Brief (“Resp. Br.”).

3. I incorporate by reference the portions of my Opening Decl. in which I state my background, qualifications, compensation, and materials reviewed. I provided a copy of my complete curriculum vitae as an attachment to my Opening Decl.

4. Although I am not a lawyer, I incorporate by reference the portions of my Opening Decl. in which I summarize my understanding of the legal standards that apply when considering claim construction and definiteness. I have applied those standards in this report when forming the opinions expressed in this report. I further incorporate by reference my understanding of Level of Ordinary Skill in the Art and the Summary of the ’879 Patent section from my Opening Decl.

5. If Neonode or Dr. Rosenberg provides additional detail regarding the claim construction of the ’879 patent, I reserve the right to respond accordingly. To the extent I have not addressed any particular opinion offered by Dr. Rosenberg in his Declaration, that does not mean that I agree with Dr. Rosenberg’s opinion.

## I. CLAIM CONSTRUCTIONS

### A. “gliding” (’879 Patent, claim 1)

#### 1. The N2 uses a “drag” and “drag and drop” under Neonode’s criteria.

6. I have been asked by counsel for Defendants to opine regarding whether the Neonode N2 device uses a “glide” or a “drag and drop” under the criteria Neonode and Dr. Rosenberg use to distinguish between those gestures.

7. One criteria they have used to distinguish those gestures is a “glide” is performed without lifting the thumb/finger, but a “drag and drop” includes lifting the thumb/finger. Resp. Br. at 15 (requiring a “glide” be performed “without lifting the finger” and “without lifting the thumb”) (citing Resp. Br. Ex. 5 at 348, 425-426).

8. A second criteria Neonode and Dr. Rosenberg have used is that the “endpoint is not significant” for a “glide” but that it is for a “drag and drop” which, for example, must end in a “specific area.” Resp. Br. at 17 (distinguishing a glide from a drag because the “endpoint is not significant” for a “glide” and in a drag-and-drop operation “you’re selecting an icon then you’re moving it to a precise location”); Resp. Br. Ex. 24, ¶ 93 (citing Resp. Br. Ex. 18 at 44:6-17; 46:1-8); Resp. Br. at 13 (arguing a POSITA would understand a “drag-and-drop” gesture ends in a “specific area”); Resp. Br. Ex. 24, ¶ 70.

9. Neonode and Dr. Rosenberg do not distinguish between a “glide” and a “drag and drop” based on whether there is any visual feedback, such as the representation moving during the gesture. According to them, a “drag and drop” does not require visual feedback, although they say such feedback is typical. Resp. Br. at 16 (“visual feedback is typical but is not a necessary element of a drag-and-drop operation”); Resp. Br. Ex. 24, ¶ 86 (visual feedback “not a necessary element of a drag-and-drop”), ¶ 89 (lack of visual movement is irrelevant). According to Neonode, what is “important” for a drag-and-drop operation is that from the “perspective of

the user,” an object is “logically dragged (and behaves as if it is being logically dragged) . . .” Resp. Br. at 16. And according to them, a “glide” can include visual feedback where the icon moves with the motion. Op. Br. Ex. 19 at 52:23-24 (Neonode telling PTAB during Samsung IPR hearing that “you could have a gliding motion where the icon moves with you”) (emphasis added).

10. In order to investigate the operation of the Neonode N2 device, I instructed an attorney of DLA Piper how to execute certain gestures on the N2 device. I directed and observed the operation of the device via video conference. Below (Figure 1) is an image of the display screen of the Neonode N2 device. This appears to be the same device depicted operating in the N2 device video Neonode relies on in its response claim construction brief. *See, e.g.*, Resp. Br. at 14-15; Resp. Br. Ex. 24, ¶¶ 75-77.

11. The portions of the N2 device video and gestures discussed by Neonode and Dr. Rosenberg start with the N2 device showing the display screen shown in Figure 1 below. The display screen includes three sets of arrows pointing up, each of which represents a vertical motion that can be performed by the user. Below each of the sets of arrows is a symbol, formed in the black plastic below the display. It is difficult to see those symbols in Figure 1.

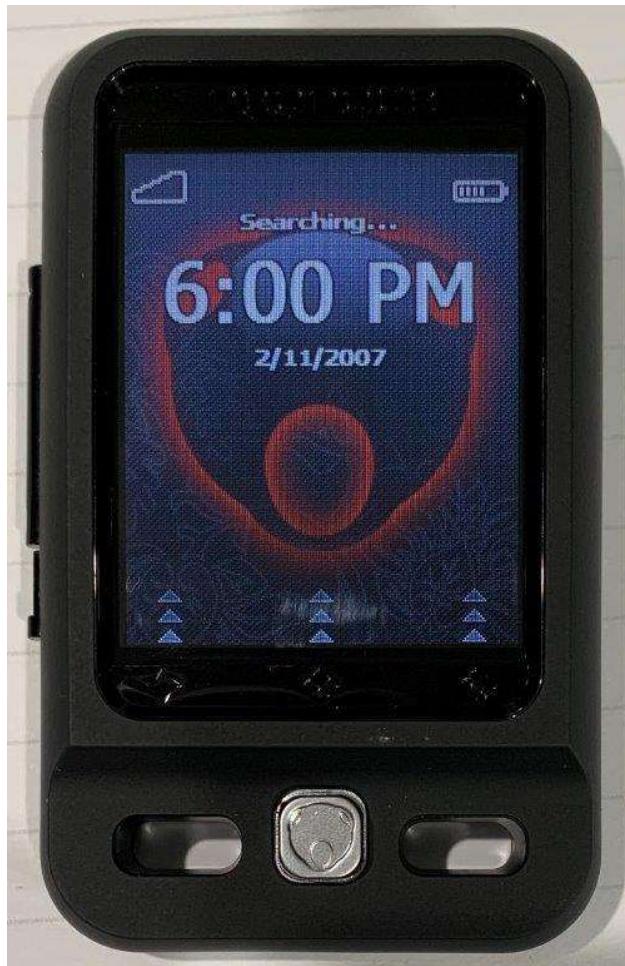


Figure 1, Starting Display Screen

12. Figure 2 shows the same N2 device but with a ruler and a U.S. quarter pictured as well for scale.



Figure 2, N2 With Ruler and Quarter

13. For purposes of my investigation, I directed the tests be performed using the area around the middle arrows and symbol. The N2 device is very small and the tests were performed using the user's thumb. Thus, the initial contact of the user's thumb contacted both the arrows on the display and the symbol on the plastic below the display. Certain gestures beginning in that area will cause the N2 to activate the display of a keyboard. Figure 3 below shows an image of the N2's display screen after activation of the display of the keyboard.



Figure 3, Display of Keyboard

14. Figure 4 illustrates the first gesture tested on the N2, which consists of the following actions: (1) touching the display in the yellow area; then (2) moving the touch from the yellow area to the green area; and then (3) lifting the touch while in the green area. This first gesture results in the activation of the display of the keyboard. This is the type of gesture relied on by Neonode and Dr. Rosenberg in the N2 device video. This gesture fits Neonode's criteria for a drag and drop because it logically drags the representation and drops it into the specific (green) area.



Figure 4, N2 Gesture 1 – Activate Display of Keyboard

15. Figure 5 illustrates the second gesture tested on the N2, which consists of the following actions: (1) touching the display in the yellow area; then (2) moving the touch from the yellow area to the green area; and then (3) maintaining the touch with the display while in the green area without lifting the touch. This second gesture *did not* result in the activation of the display of a keyboard. This gesture confirms that the gesture must end in a “lift” (a logical drop in this gesture) to activate the display of the keyboard. This test shows that the gesture in the N2 device video fits Neonode’s criteria for a drag and drop (which ends in a lift/logical drop) and does not fit Neonode’s criteria for a glide, which is performed without a lift.



Figure 5, N2 Gesture 2 – No Display of Keyboard

16. Figure 6 illustrates the third gesture tested on the N2, which consists of the following actions: (1) touching the display in the yellow area; then (2) moving the touch from the yellow area to the white area; then (3) lifting the touch while in the white area. This third gesture *did not* result in the activation of the display of a keyboard. This test shows that not all motions away from the representation and in the direction indicated by the arrows are sufficient. This indicates that the endpoint is significant, and must be in the specified area. In combination with the first gesture, this third gesture confirms that the gesture required to activate the keyboard fits Neonode's criteria for a drag and drop because it requires logically dragging the representation

and dropping it into the specific (green) area, and that merely logically dragging the representation vertically upwards is insufficient to activate the display of the keyboard.



Figure 6, N2 Gesture 3 – No Display of Keyboard

17. Figure 7 illustrates the fourth gesture tested on the N2, which consists of the following actions: (1) touching the display in the yellow area; then (2) moving the touch to the blue area; then moving the touch straight up the screen to the white; then moving the touch to the left to the green area; then (3) lifting the touch from the green area of the display screen. This fourth gesture also resulted in the activation of the display of a keyboard. This test shows that the path traveled by the gesture is not relevant, so long as the gesture begins with a touch in the yellow area and ends with a lift in the green area. I had this gesture repeated using different

paths, and the particular path illustrated in Figure 7 is merely representative of the fact that the path does not matter. This test is additional evidence that the N2 gesture is a logical drag and drop, since the direction and length of the movement is not relevant as long as the representation is dragged and dropped in the specific area.

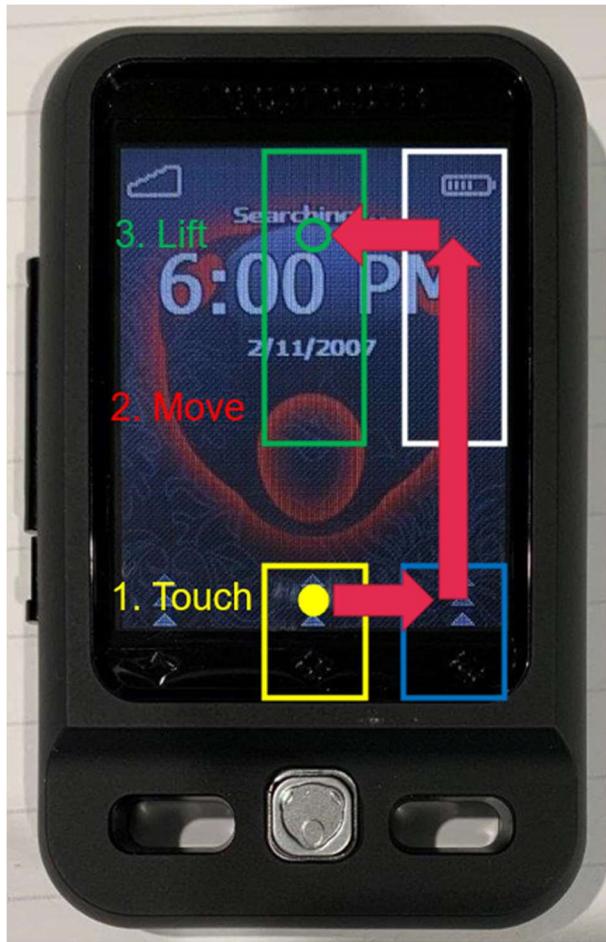


Figure 7, N2 Gesture 4 – Activate Display of Keyboard

18. Figure 8 illustrates the fifth gesture tested on the N2, which consists of the following actions: (1) touching the display in the yellow area; then (2) moving the touch straight up the screen from the yellow area to the green area; then moving the touch from the green area to the white area; then (3) lifting the touch while in the white area. This fifth gesture *did not* result in the activation of the display of a keyboard. This test again confirms that a “glide” under

Neonode's criteria up from the yellow area and into the green area is insufficient if it does not lift/ logically "drop" the representation into the green area.



Figure 8, N2 Gesture 5 – No Display of Keyboard

19. I had each of the gestures conducted numerous times using slightly different placements to approximate the boundaries of the areas illustrated in the drawings. But the illustration of these areas are still only approximations. The display area on the N2 device is very small, measuring two inches across the diagonal. And the N2 does not sense objects at a particularly high level of resolution because it uses a discrete set of IR sensor beams in the vertical and horizontal directions. Thus, the precise boundaries of the illustrated areas are

difficult to determine through normal use. Nevertheless, the illustrated areas, while approximate, are accurate enough for purposes of determining whether the N2 uses a “glide” or a “drag” or “drag and drop” under Neonode’s criteria.

20. I had each of the above gestures performed at various levels of pressure to determine whether the N2 distinguished between gestures based on the level of “effort.” The N2 did not distinguish between the gestures based on the level of effort. This is consistent with the fact that the N2 detects a touch using IR beams, which in the N2 configuration cannot detect the level of effort applied by the user.

21. I had each of the above operations conducted at various speeds to determine whether the N2 distinguished between typical speeds a user might use. The N2 did not distinguish between the gestures based on the speed of the gesture.

22. I note that these test results are consistent with Mr. Shain’s declaration that the N2 activates a function after a “lift.” Ex. 21 (*Google LLC v. Neonode Smartphone LLC*, IPR2021-01041, Exhibit 2008 Declaration of Joseph Shain (October 15, 2021)), ¶ 6.

23. I also note that these test results are consistent with a third party review published in 2007 related to the N2, which divides the screen into similar areas (Fig. 9, below). Appx. A (*Google LLC v. Neonode Smartphone LLC*, IPR2021-01041, Exhibit 2024 Conrad H. Blickenstorfer, *Neonode N2, A New Version Of The Phone That Pioneered Touchscreens*, Pen Computing Magazine, Nov. 4, 2007 [Pen-Computing-Magazine-N2-Phone-Review]).



Figure 9

24. Based on these tests of the N2 device, it is my opinion that the N2 gesture in the N2 device video satisfies Neonode's criteria for a "drag" because the representation (whether the representation is the arrows, the symbol, or a combination of the two) is logically dragged and dropped into a "specific area" to activate the function. It is also my opinion that the N2 gesture fails Neonode's criteria for a "glide" both because: (1) the user must lift their touch to logically "drop" the representation to activate the function; and (2) the endpoint of the movement is significant because the gesture must end with a drop in the specified drop area.

25. It is also my opinion that the N2 gesture shown in the N2 device video supports my opinion that Neonode's attempt to distinguish between a "glide" and "drag" has no basis in the art and does not provide reasonable certainty to a POSTIA. The fact that both Neonode and Dr. Rosenberg classified the N2 gesture in the N2 device video as a "glide" when it is a "drag" and a "drag and drop" under their own criteria confirms their criteria are indefinite.

26. Neonode cited the operation of the N2 to the Patent Office to distinguish Hirayama-307, arguing the representation is "logically" (and not visually) dragged into the

display and dropped to activate the function. Resp. Br. Ex. 24, ¶¶ 86-89. However, under Neonode's criteria, the N2 is just like Hirayama-307 because the user logically drags the representation to a specific area of the display to activate the function in the display.

**2. The claimed “glide” motion is indefinite.**

27. Neonode relies on extrinsic dictionary definitions to assert a “glide” is “a smooth, continuous movement across or along a surface,” while a “flick” is a “sharp, quick movement.” Resp. Br. at 12-13. A flick is a “continuous movement across or along a surface.” For example, a “flick” moves along a surface and is not discontinuous.

28. I also note that the distance of movement in the N2 gestures that can activate the display of the keyboard can be very small. Figures 2 and 6 from above are reproduced below to illustrate this point.



Figure 2, N2 With Ruler and Quarter



Figure 6, N2 Gesture 3 – No Display of Keyboard

29. In the N2, the keyboard can be activated by a gesture that is relatively short, as long as it starts in the yellow area and ends in the green area. The minimum distance required between the touch and lift is shown by the white area in Figure 6, which is on the order of a quarter of an inch. I note this because Neonode and Dr. Rosenberg indicate that one criterion for distinguishing between a “glide” and a “flick” is the distance of the movement and, for example, whether it constitutes an “appreciable portion of the display.” But neither Neonode nor Dr. Rosenberg try to explain how to apply that distinction, and a POSITA would not be reasonably certain how to apply it. A POSITA would not be reasonably certain, and would have no objective guidance, as to whether a movement on the order of a quarter of an inch by a thumb on a touchscreen constitutes a “glide” or a “flick.”

30. Neonode states in its Response Brief that as shown in the Neonode N2 device video, “the movement is a smooth glide” and “[i]t in no way resembles a ‘flick.’” Resp Br. at 14. Dr. Rosenberg stops short of repeating this second sentence in his declaration (that the glide in no way resembles a flick). Resp. Br. Ex. 24, ¶¶ 75-76. Indeed, when viewing the Neonode N2 device video (Resp. Br. Ex. 14), there are plenty of examples of user gestures that do resemble a flick, including at 00:33 (the moment after Neonode’s cited screenshots at 00:26-00:27), 01:30, and 02:23. A POSITA would understand these movements in the N2 device video to be sharp, quick, and continuous across or along a surface, all of which are Neonode’s parameters for determining when a gesture is a flick, not a glide.

## II. CONCLUSION

31. For the reasons set forth above, I disagree with the opinions expressed by Dr. Rosenberg in his Declaration. It is my opinion that claim 1 of the ’879 patent is indefinite for the reasons discussed above and set forth in my Opening Declaration.

Date: June 9, 2023



Andy Cockburn

## **APPENDIX A**

Leesa

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## Neonode N2

**A new version of the phone that pioneered touchscreens**



November 4, 2007 -- This is a review of the Neonode N2, a little multimedia touchscreen phone that almost no one has ever heard of. It's different from anything else on the market, although since the advent of the Apple iPhone no longer quite as different as it once was. Listening to Apple's claims of all the patents covering the iPhone's user interface one might assume the iPhone broke completely new ground and went where no phone had ever gone before.



That is not entirely so. Neonode, a small Swedish company with headquarters in Stockholm and a US office in San Ramon, Calif. (a somewhat complicated merger took place in early 2007 between US-based and publicly traded SBE, Inc and Neonode, with the resulting company called Neonode, Inc.), announced the Neonode N1 back in 2002. It was very small. It had no keypad or keyboard at all. It did not use a stylus either. Instead, it used a swipe and tap system on a novel touch screen that used a grid of infrared beams to sense finger movement.

So those who marvel at how a swipe from left to right unlocks the iPhone, well, the Neonode N1 was unlocking that way more than five years ago. And if the iPhone's swipes and taps seem futuristic, they are not. Neonode has been using them since the first N1 came out. In fact, the company's Neno user interface is based entirely on swipes and taps. With one exception. Just like the iPhone has that one physical button below its display, the Neonode does have a 4-way navigation stick that's used for this and that. It's not even needed much.

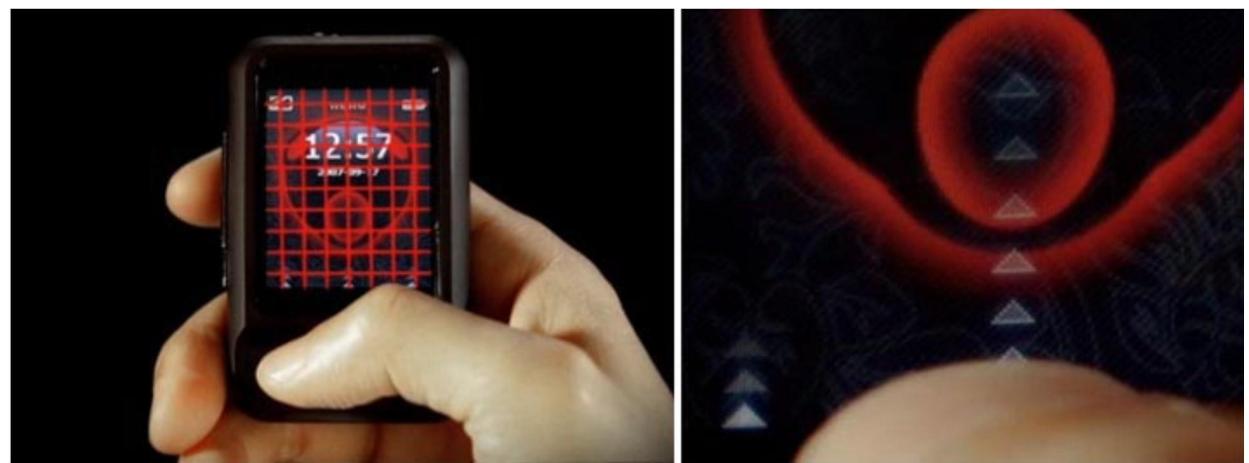
We reviewed the predecessor of the N2, the Neonode N1, in great detail ([see our review of the Neonode N1](#)) and I have now

lived with the new N2 for several weeks. The N2 is different and, coming from a nearly unknown manufacturer, faces an uphill battle to claim its place in the sun. Based on what we've seen, it certainly deserves your attention.

## The swipe and tap system

To get right to the heart of the matter, the Neonode N2 is operated by swipes and taps even more so more than the iPhone that still uses some conventional menus. Initially the N2 interface seems a bit confusing and you can get lost. However, play with it for just a few minutes and all falls into place and makes sense. The swipe & tap system is implemented very consistently throughout the N2's applications and setup screens, though there are some exceptions that can throw you.

We captured the below pictures from a video on the Neonode site. **The red grid on the left is not actually visible. That just illustrates the grid of infrared beams the N2 uses to detect your finger.** The close-up on the right shows little arrows. They always show up on the screen to show, or remind, you where you can swipe to make things happen. You operate the N2 entirely with swipes and taps.



Here is how it works and fits together and how you use it:

The Neonode N2's display is separated into functional areas. There are horizontal areas and vertical areas.

### Horizontal swipes

Horizontally, the Neonode's display is divided into three areas.

The top is the **"change view"** area. Swiping left and right may move through tabbed menus or bring up different screens of an application.

The center in the **"navigation area"** where you can navigate up and down and left and right within a view.

At the bottom is the **Accept/Close/Notification** area. It is used for two purposes. Swiping right is usually equivalent to "ok" or "accept." Swiping left is generally equivalent to "esc" or close. Sometimes an application uses that area to prompt for input from the user, like tapping on it to bring up options.



### Vertical swipes

Vertically, the left third of the screen is the **"Start menu swipe area"**. The center third is the **"keyboard swipe area"**. And the right third is the **"tools menu swipe area"**.

To close an application entirely, you do a diagonal swipe from upper right to lower left. To select an item from a list, you swipe up and down, then tap, just like on the iPhone. With the difference that Neonode phones have been doing it this way since 2002.

### How it works and what screens look like

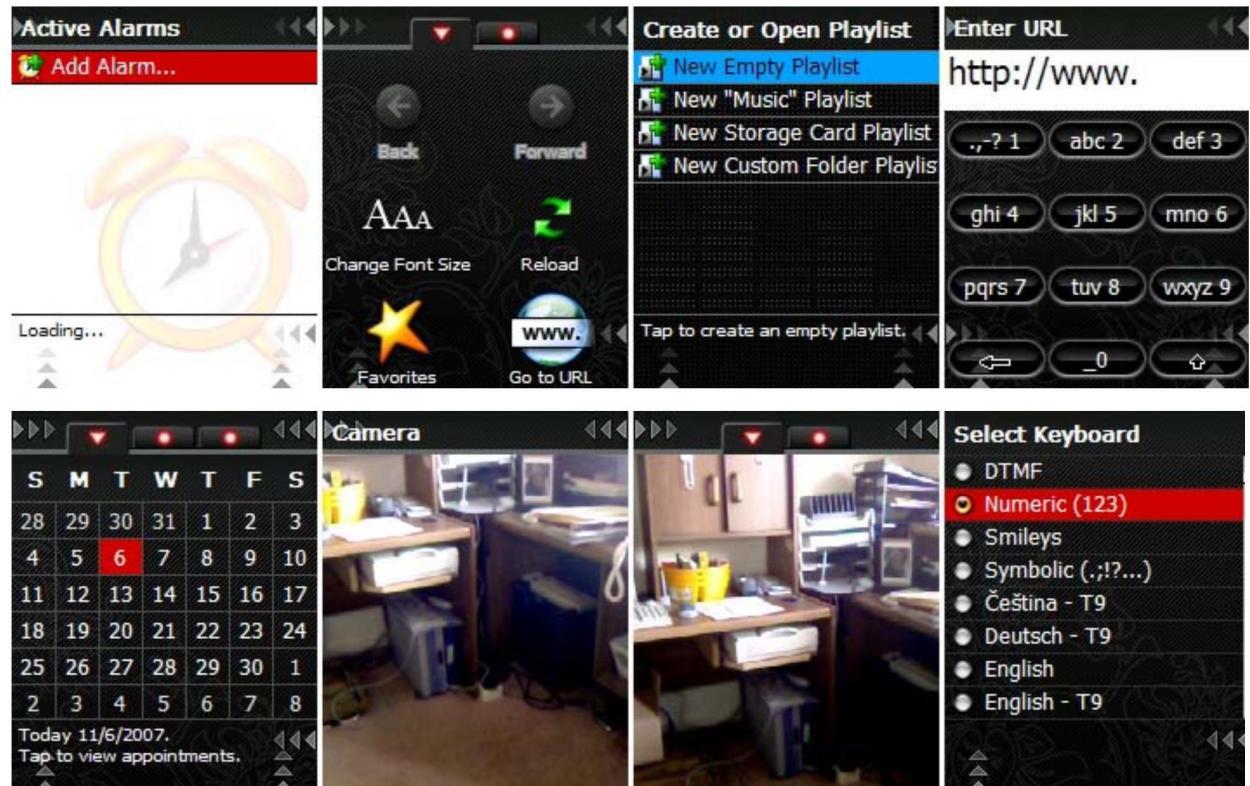
Below are a few N2 screens that illustrate how it works. On the left is the Alarms screen. Swiping up along the left would get you back to the Start menu. Swiping up on the right would bring up a utility/settings screen like the one shown next to it. Swiping right to left at the bottom backs out.

The second screen is the utilities screen for the built-in browser. It, too, is tabbed so you can swipe right along the top to get to the next screen. To select a function, tap on it.

The third screen shows a playlist. Here you'd scroll up and down by swiping, or tap in the Accept/Close/Notification area to create a new one.

The fourth one shows the standard keyboard that is used for phone calls and data entry. Tap in the URL or phone number, then swipe bottom right to enter, or bottom left to back out. Simple as that.

Below that are a few more N2 screen: calendar, camera live view and playback, and the different data entry methods you can select.



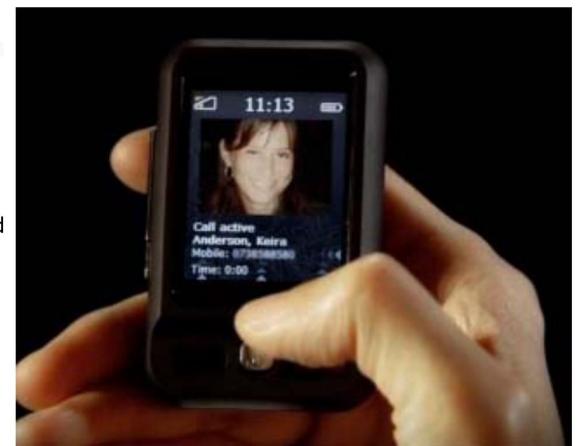
## The Neonode phone

When we did our detailed review of the Neonode N1 a while ago we commented on its relatively large size and dated design. That's because it went all the way back to 2002, an eternity in cellphone product cycles. When it was conceived, the N1 had been considered tiny and sleek, but by 2006 it was, for a cellphone, large and a bit dated with its shiny plastic body and overall design. Truth be told, the N1 was no larger than a 2007 Sanyo flip phone I am using, but the Sanyo is an inexpensive, utilitarian lossleader whereas the Neonode was supposed to knock your socks off.

Well, the N2 is a different story altogether. It is tiny: 3 x 1.8 x 0.59, and it weighs 2.1 ounces. That is small, and Neonode claims it's the smallest form factor in the mobile phone industry. It is a marvel in miniaturization in every respect. It's cute and definitely a conversation piece.

The N2 is an **unlocked** quad-band GSM phone, which means you can use it with any GSM-based carrier. You're not locked in like iPhone customers. That is a huge advantage. To insert the SIM card you manipulate a slider on top of the device and then open the clamshell housing. This opens up the entire inside of the N2, but where you'd expect the usual circuitry, all you see is the Sim card slot, the MiniSD card slot, the camera and that's about it. No exposed electronics. They all must be condensed into an incredibly small space on the backside of the display.

The battery is integrated into the back part of the N2's housing. It is a Neonode-branded Li-Ion rechargeable providing 3 watt-hours



(3.7V/820mAH). That's on the order of what you find in today's ultra-slim digital cameras and is supposed to yield up to four hours of talk time and over eight days of standby. But while those camera powerpacks are replaceable and to some extent standardized, it looks like you'll have to replace the entire backside of the N2 if the battery dies. Below you can see what the N2 looks like inside. The picture is actually way larger than the phone is in real life.



## Using the phone

The N2 is, of course, foremost a phone, and a pretty good one. There are no green and red buttons. Swipe right to answer or place a call, swipe left to hang up. When you make a call with the N2, you hold its backside against your ear, and not the screen. That results in far fewer greasy smudges and really makes more sense, though you have to get used to it.

You swipe up the middle to bring up the keypad, dial, then swipe right to call. When you're done, swipe left to hang up.

In Phone mode, swiping right brings up Contacts either as icons or as a list of contacts. Swiping left terminates the Phone mode and returns to the status screen.

Like with most phones, you can use the "Call History" screen to quickly place a call. Select a call and you can see what number it was to, who it was to, what time the call was placed, and how long it was.

Alternately, you can use the Address Book. Addresses are listed alphabetically either by last name or first name. You can toggle between address book and favorites, and there are various settings. A neat touch: if an explanation does not all fit onto a line, the text moves backwards and forwards so that you can read it without having to do anything at all. The screen on the right above shows the N2's dial pad. Below are a few of the phone options: the address book, telephony settings, phone options and keyboard settings.

Number To Dial





### Sending an SMS

To send a SMS text message to someone, you select them from the address book, swipe up into utilities, select "Send Message" and type the message. Alternately, you can tap on the Messaging icon and start a new message. You can select from numerous keyboards (or rather keypads, including the standard cellphone way of doing it, Tegic T9, numeric, Smileys, symbols, and, this being an international phone, half a dozen of the world's major languages).

### The display

The N2's display measures 2.0 inches diagonally. It is 176 pixels wide and 220 pixels tall. That makes for a resolution of about 141 dots per inch. That is less than the iPhone, but still considerably sharper than most computer displays. It can show 65k colors and it is significantly better readable outdoors than most phones. Of course, it needs to be readable as there is no hardware keypad. The display surface seems to be plastic, which makes it more prone to scratches than glass.

### Built-in 2-megapixel camera

There's a 2-megapixel digital camera that can take very passable pictures. The camera application uses the entire screen with the exception of the tab bar on top of the display. There you toggle between camera and image viewer.

You can select from picture resolutions from 174 x 144 all the way up to 1600 x 1200. You can set White Balance (auto, home, office, outdoor, cloudy, sunny), Brightness, Color Saturation with sliders on a 1-8 scale operated by the joystick, and also set vibration and sound on or off.

In playback mode you can make pictures fit the little screen in width or height, view them in actual size (you pan around), rotate them, add them to a contact, save them as wallpaper, or even send them as a MMS or via Bluetooth.

In a comparison with the iPhone's highly touted camera that also does 2-megapixel, the N2's camera does quite well. Snapshots were of similar quality.



### NeoMagic MiMagic 6+ processor

Interestingly enough, while the Neonode N2 runs its Neno interface on top of Windows CE 6.0, the hardware is based not on one of the better known Marvell XScale chips or ARM-based processors from Samsung and others. Instead, Neonode has a long-standing relationship with NeoMagic Corporation (the similarity in names is totally coincidental), a semiconductor company headquartered in Santa Clara, Calif. NeoMagic very much believes in a great future for multimedia phones and aims to cover that market with high performance application processor chips that run on very little battery power.

To do that, they use a technology called APA, which stands for Associative Processing Array -- programmable parallel processing where multiple operations are performed in each processor cycle. In essence, NeoMagic seeks to replace all the complex and powerhungry specialized hardware accelerators and DSP chips with one programmable parallel processing chip that can run MPEG-4, H.264, full duplex 2-way video and such. The chip itself, the MiMagic 6+, combines an ARM 9 core with an APA-based multimedia engine (see [MiMagic 6+ block diagram](#)). Performance is very good. There is virtually none of the delay you've come to expect from a Windows Mobile device. Everything happens instantly -- likely a benefit of having an optimized proprietary interface interacting directly with embedded Windows CE.

## Unique "zForce" infrared touchscreen

Equally interesting is the Neonode's touchscreen that was used in the N1, and now in the N2. It employs a patent-pending technology called "zForce" that enables a touch screen unlike any you've used or seen on such a small device.

In contrast to most touch screens that sense the pressure of a stylus or a finger, the Neonode's zForce technology uses a grid of infrared beams to determine the location of your finger. The grid consists, I believe, of ten horizontal and eight vertical "beams." You can't see them as they are integrated in the roughly 1/16-inch rise of the bezel that surrounds the display. This is how the display senses the location of a finger.

An array grid of nine by eight intersecting infrared sensors obviously is very different from a conventional digitizer. It is not meant for handwriting recognition or digital ink. You can't write or draw on the N2's screen with a stylus. Instead, the zForce infrared grid is used to determine the position of your finger and the direction in which you swipe a finger. The latter ability is used to give the Neonode its unique personality and mode of operation. In contrast, Apple combined a projected-capacitive touchscreen that is capable of interpreting multi-point touch, allowing the now famous "pinching" to zoom in and out.

Neonode added another interesting feature that the iPhone does not have. When you dial a number, type, or provide other input, the phone provides a tiny vibrating feedback to tell you that it registered your touch. This is invaluable and greatly adds to the usability of such a small device. You *know* your input has been received. You don't even have to look.

Note that infrared touch by itself is not a new technology. It originated in the late 1970s and is widely used in point-of-sales terminals and ATMs. However, Neonode pioneered its use in mobile devices and they managed to shrink the required technology first in the N1, and now even more, by a significant degree, in the N2.

## PC communication

Amazingly, if you connect the N2 to a PC with Microsoft ActiveSync installed on it, ActiveSync will recognize the N2 as a Windows Mobile device without any problem at all and you can set up a partnership. Then things work as they do with any other Windows Mobile device.

You can also click "My Computer" on the desktop or notebook the N2 is connected to and then select "Mobile Device." Once again, the Neonode's file system will show up there and you can drag and drop files any which way you want.

What this means is that you can use standard Microsoft ActiveSync and set up a relationship between the N2 and your desktop or notebook computer. Or you can use the N2 essentially as a USB drive, just dragging files onto its miniSD storage card.

Mac users, however, are out of luck.

## Will it hold up?

How well does this clamshell design keep out dust and moisture? There isn't an O-ring for sealing and I would not expect the N2 to be waterproof, but neither have I found dust in it so far. In fact, the N2 seems a more durable design than the N1 was. Light weight makes a device inherently less prone to damage from falls, and at 2.1 ounces, the N2 can probably survive rather substantial drops. Its surface is matte-black and has a rubbery feel to it. Apart from the display getting crunched by force, I can't see the N2 getting damaged or broken in everyday handling. Also, "soap bar" designs don't have a hinge to worry about -- the part that almost always breaks or gives out first in flip phones.

## What is different in the OS?

All Neonode phones are running the very innovative Neno interface on top of Windows CE. I am not sure what version the N1 used, but the N2 runs Windows Embedded CE 6.0 Pro. This is a componentized operating system designed for small footprint devices. It's an impressive architecture with impressive features and excellent development tools. The new 6.0 kernel can handle 32,000 simultaneous processes with huge virtual memory space, the file system supports media and file sizes up to 4GB, there is plenty of driver support, it's SDL (Security Development Lifecycle) compliant for security, and it runs on x86, ARM, SH4 and MIPS based processors. It is media-friendly, supports multiple video streams, and designed for optimal cellular networks voice and data connections. Platform Builder for Windows Embedded CE 6.0 is a plug-in for Visual Studio 2005, various Microsoft development technologies are available (Win32, .NET, or MFC), there are device emulators, and developers have source code access. To view the Windows Embedded CE 6.0 product brochure, [click here](#). What exactly the "Pro" designation signifies, is unclear.

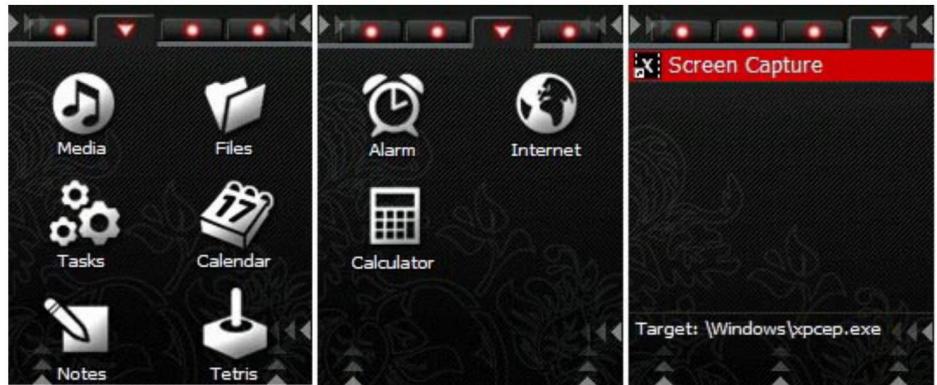
## The Neno 2.0 interface

The swipe and tap-driven Neno OS interface looks different from earlier versions, albeit not that much. The basic theme now is an almost monochromatic white on black with red glow whereas the N1 used a red background. The N1 had color icons that looked very Windows CE-like whereas the N2 has white icons that have labels beneath them. To be honest, I prefer that. It immediately makes it clear what an application does instead of having to first interpret the icon, and it is especially helpful in submenus. Whereas the N1, for example, used the standard Microsoft Internet Explorer icon, the N2 has its own and the

splash screen says "NeoExplorer." With the N1, different screens were shown as a row of dots along the top of the display. The N2 uses a tabbed system. The basic set of applications remains unchanged. Unlike the Windows CE/Windows Mobile interface with its list of apps on the Start menu and everything else in one big Program screen, Neno offers a clean, tabbed icon-based system where you flip from screen to screen with swipes. The screens are customizable. The default offers the following pages:

Page 1:

- Status Screen
- Contacts
- Lock
- History
- Camera
- Messages



Page 2:

- Music
- Files
- Video
- Calendar
- Notes
- Tetris

Page 3:

- Alarm
- Internet
- Calculator
- Tasks

Page 4: all your shortcuts

You can move items on the first three pages, and add others. On Page 4 you can add your own shortcuts.

Personally, I feel Neno needed some other changes. As intuitive as the swipe and tap interface is for the most part, some aspects are confusing and I never got used to them. For example, it can be confusing how to switch between applications or escape out of a settings screen without completely closing an application and having to start over. Apple elegantly solved this issue, and Nenonode should, too.

## The Start menu

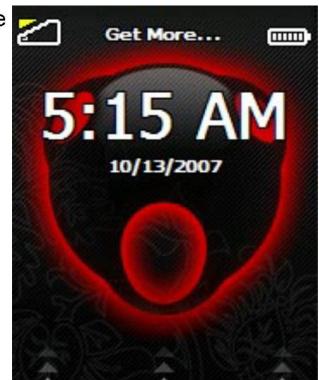
The N2's opening screen shows a red-glowing Neonode icon on a dark screen. It shows three sets of up arrows along the bottom of the display.

Swipe up the **first** and you get into program selection. The first program screen shows up with six icons that you can tap. Subsequent program screens can be selected via tabs along the top of the screen. Swipe left or right along the top to select those tabs. The Start Menu can be customized. You can move applications around, assign icons and actions and even images.

Swipe up the **second** and you're in phone mode. A standard numeric keypad shows up.

## Settings

Swipe up the **third** and you get a settings screen. Settings are grouped into Display, System, Communication, and Audio, all represented by a tappable icon.



**Display** lets you customize the Status Screen; select Themes; set backlight level and duration; show or hide Menu descriptions; show or hide gesture hints; and set the KeyLock timeout.

**System** lets you set date and time; regional settings; display system information; error reporting on or off; and the device name (which can be changed).

**Communications** sets telephony, GPRS, and Bluetooth

- Under Telephony, you can set call waiting to active or inactive; set and change a PIN code; getting a list of available networks and selecting from one of them (in my case, it found T-Mobile and AT&T Wireless); enter and change the SMS Central number; clear the voice message indicator; and set call forwarding status.

- Under GPRS you detect GPRS access points.
- Under Bluetooth you can either enable or disable Bluetooth; discover devices; and select the active headset.

**Audio**, finally, sets the Loudspeaker on or off; enables or disables the vibrator; sets the ringtone; sets the volume; routes ringtone to headsets, if worn, or not; sets the call default volume; and sets audio for alarms, appointments, birthday reminders, and incoming message alerts.

Navigation is always the same: swipe up to get into either program screens, phone mode or settings. When presented with a menu list, use the navigation stick to move up and down, then tap field to select that choice. Selecting may either toggle between values or bring up another screen with a list.

Swiping left at the bottom is "esc" or backing out. Swiping right is "ok" and accepting a selection.

### Other apps

Below are screenshots of some other applications. NeoExplorer is an adapted version of Internet Explorer. There is a rather addictive Tetris game. You can use the Notes application to type documents of any length. Frequent SMS users will probably use the Tegic T9 text entry method that's on most cellphones. The screen on the right shows all currently running applications.



### The N2 as a Media player

Neonode stresses the N2's media player talents, and they have a point. Everything is saved on a standard miniSD card, and you can stick in any size card.

The N2 can accommodate standard 3.5mm headphone plugs. The plug does not go directly into the N2, but into a tiny volume and pause/play control that has a little rocker to adjust volume in 20 steps.

The media player is Windows Mobile-based, but uses the cool Neno interface. Operation is slick and easy, and the M2 plays MP3, WMA and Wav audio files and MPEG and WMV video. Video on a 2-inch display in 176 x 220 resolution has its limitations, of course, but you get used to it, especially since the N2 has excellent stereo sound through its very good and nicely padded headphone buds.

The latest version of the Neno software provides separate icon access to music and video files. That makes sense.



### How does the N2 compare to the N1?

Not many people will be in a position to compare their old Neonode N1 with the new N2 as not very many N1s were sold, and none in the US. Still, it is interesting to see how Neonode advanced the technology. Also, Neonode had generated considerable hype about the N2 and that led to lofty expectations. Just like the Neonode phone itself, Neonode marketing is, well, different. Witness the [Pregnant man blog](#) leading up to the official announcement in February of 2007.

Anyway, place the N1 and N2 side by side, and it's immediately clear that the N2 is a far more advanced design. It is smaller (3 x 1.8 vs 3.4 x 2.1), much thinner (0.59 vs 0.8) and much lighter (2.1 ounces vs. 3.2 ounces).

The screen has the same 176 x 220 pixel resolution, but the N2's is smaller (2.0 inches vs. 2.2 inches diagonal). The zForce touch screen requires a recessed screen so that the infrared sensors can span their grid on top of it. The N1 screen was recessed about 1/8th of an inch whereas the N2's is only recessed about 1/16th of an inch. This actually makes a huge difference in everyday handling. The shallower recess makes the device look better and you no longer bop into the sides quite as much as with the N1.

Both the N1 and the N2 have physical four-way navigation in addition to the touch screen. However, whereas the N1's was a somewhat odd and unwieldy plastic shield where you had to depress flaps, the N2 has a handy little navigation stick. It's still not perfect as it is slippery and requires too much force, but it is much better.

The N1's 1-megapixel camera had a weird square 1024 x 1024 pixel format whereas the N2's 2-megapixel imager uses the standard 1600 x 1200 pixel format. Both the old and the new device have a black plastic housing, but whereas the N1's was glossy and slippery, the N2's is matte and has a rubberized feel that makes it much easier to hold, and there are no reflections.

The camera application now uses the entire screen to view the picture whereas on the N1, it was just a small window. However, whereas what you saw on the N1 was pretty much real-time, the N2's display becomes blurry and falls way behind when you move the camera.

Another cool improvement: In most applications, when you type, Neno starts out with a large, very readable font, then switches to a smaller font once you reach the end of the first line. That makes a lot of sense.

One thing that has changed, dramatically, is the responsiveness and accuracy of the zForce touch screen. The N1 occasionally struggled to properly interpret a tap in the center of the screen, where the "5" is on the calculator and on the phone dial pad. That is no longer a problem with the N2. Also, this being a touch screen using infrared, strong daylight tended to affect the N1's operation. The N2 seems virtually immune to daylight interference -- likely using special filters and specific frequencies to differentiate from the infrared component of sunlight.

My N1 ran the Neonode Neno OS version 1.4.394, the latest one available; my N2 initially ran version 2.1.290.6 which works the same way but is considerably more user-friendly thanks to the addition of text labels instead of just icons. Just before this review was published, I downloaded the latest version, 2.1.339.5, which fixes a number of bugs and is said to improve battery life. It also replaces the "Media" icon with separate "Music" and "Video" icons that launch the music and video players, making things simpler.

So the N2 is quite different from the N1, but some say not different enough. They had hoped for WiFi (we had, too) and perhaps more substantial hardware improvements. But the company apparently believed better design and ultra-small size was the road to go.

## The Neonode N2 and the Apple iPhone

As far as the Neonode folks go, the iPhone is likely a huge thorn in their side. I am sure in legal terms the respective intellectual property has been respected by all, but it must be vexing to see Apple essentially claim ownership of concepts the Neonode phone has been using for at least five years. On the other hand, Neonode may view the glass as one-quarter full and welcome the iPhone as Apple's product sure legitimized the touchscreen for phones and a lot of people are looking at the Neonode who otherwise would have simply written it off.

As the picture below shows, one thing is instantly clear: if you like your phone as small as it can be, the Neonode is the clear winner. The screens are simulated here, hence the different times, but both are, in fact, clearly viewable in bright daylight.





And here is how the two compare:

### Apple iPhone vs Neonode N2

	Apple iPhone	Neonode N2
<b>OS</b>	OS X	Neno on top of Windows CE 6.0 embedded
<b>Size/volume</b>	2.4 x 4.5 x 0.5 inches/5.4 cubic inches	1.8 x 3.0 x 0.6 inches/3.24 cubic inches
<b>Weight</b>	4.8 ounces	2.1 ounces
<b>Memory</b>	8GB built-in	1GB miniSD card
<b>Bluetooth</b>	yes (2.0+ EDR)	yes
<b>WiFi</b>	yes (802.11b/g)	no
<b>Cellular voice/data</b>	GSM quad-band 850/900/1800/1900 MHz, EDGE	GSM quad-band 850/900/1800/1900 MHz, GPRS
<b>Display size and resolution</b>	3.5 inches; 320 x 480 pixel (163 dpi)	2.0 inches; 176 x 220 pixel (141 dpi)
<b>Camera/video</b>	2 megapixel (1600 x 1200); no video	2 megapixel (1600 x 1200); no video
<b>Touch technology</b>	Projected-capacitive touch with multi-point touch	zForce infrared touch
<b>Navigation/operation</b>	Swiping/tapping and control button	Swiping/tapping and 4-way navigation stick
<b>Battery</b>	Integrated Li-Ion rechargeable 1400mAH, 3.7Volt (5.2 watt-hours)	Integrated Li-Ion rechargeable 820mAH, 3.7Volt (3.0 watt-hours)
<b>Battery talk time</b>	"up to 8 hours"	"up to 4 hours"
<b>Windows/Mac</b>	iTunes 7.3 or later Windows or Mac	Windows (ActiveSync); no Mac support
<b>Browser</b>	Safari	Internet Explorer
<b>Email</b>	POP3 and IMAP4	none (SMS and MMS available)
<b>Application development</b>	Safari-based	Visual Studio and other Win CE tools
<b>Carrier</b>	AT&T	unlocked
<b>Price</b>	US\$399 with 2-year AT&T service agreement	Euro 439, no service agreement needed

From a technology point of view, Neonode clearly counts on touch as the up-and-coming technology in smartphones. Here, the broad acceptance of the iPhone certainly helps, though the iPhone's projected-capacity/multi-point touch technology is different from Neonode's zForce IR touch technology. A 2007 iSuppli forecast ("Touch Screens: The Right Touch for High

Growth") predicts 20.7 million projected-capacity mobile phones by 2012, still fewer by far than more conventional resistive touch phones (65.7 million) and just 3.8 million using other touch technologies. A 2007 forecast by Strategic Analytics sees far higher numbers for touchscreen phones, mostly capacitive. [Walker Mobile's forecast](#) is between the two and views the projective-capacitive method used by Apple as becoming widely adopted.

## Neonode N2 -- The Bottom Line

It is hard to judge the Neonode N2 because it is so different. For an analogy, I can image that car magazine editors in the 1970s felt that way when they reviewed cars with rotary engines. They were very different and offered compelling potential. The Wankel motor was small and elegant, offering excellent performance with very little complexity. Was it the future or just an oddity? It is almost 40 years later and one of the most fascinating cars on the road, the Mazda RX8, is rotary-powered. Yet, it's the only one. Great idea, but for a variety of reasons it just didn't catch on. Neonode hopes that won't apply to its technologies.

On the plus side, the Neonode N2 represents a convincing proposition. Take very solid underpinnings -- Windows CE 6.0 -- but use a much simpler, much more elegant operating environment. Provide complete one-handed operation via a clever swipe-and-tap system that also uses a novel touchscreen that provides feedback in the form of vibration. Make it unlocked so users can pick their own carrier. Then package the whole thing in an ultra-elegant, tiny form factor, the smallest one out there. What you now have is an instant conversation piece built on exotic technology. And one that works very well.

On the other hand, Apple not only stole Neonode's thunder, whatever there was, but also trumps Neonode in several areas. The little N2 does not have WiFi, does not have an email client, and despite Windows Mobile underpinnings, has essentially no third-party software. It's also not a true 3G phone and really doesn't offer more in terms of on-board software than a garden variety smartphone, and in some areas less. Maybe the expectations were too high and gadget freaks expected the N2 to have WiFi, GPS, 3G, mobile TV and more. It doesn't.



Then there is the carrier issue. Being unlocked is great as you can stick in any old SIM card and the N2 works. But it must then be configured to work with the carrier's data service. And without the dreaded 2-year service agreement contracts that subsidize almost all phones these days, the N2's price is high. It certainly does have the distinction of having pioneered many of the concepts that Apple now claims as its own with the iPhone. But as is, the iPhone offers more for less, which means that once brought to the US, the N2 would have to be very competitively priced with a carrier bundle, and it must have 3rd party software.

There is a place for the Neonode N2 even without that, of course. Marketing will be one of Neonode's big challenges. Maybe there could be co-branding or targeted editions, or bundle deals with additional software and media on large memory cards. There are always people who appreciate better ideas and solutions, even if they are implemented in niche products. The N2 is that, but as a pioneering and beautifully engineered and highly functional product with its deliciously tiny size, it definitely deserves wider recognition.

### Neonode N2 highlights:

- Tiny, beautifully designed and executed multimedia smartphone
- Unique IR-based touchscreen with vibrate feedback
- One-handed operation via slick Neno swipe & tap interface
- Speedy operation; generally much faster than standard Windows Mobile devices
- Unlocked GSM phone
- Unique and different
- Windows CE 6.0-base means connection via ActiveSync and lots of software tools
- Can connect like a USB drive
- Very good 2-megapixel camera

### But keep in mind:

- No WiFi or GPS
- Virtually no 3rd party applications
- No email client
- Some parts of the interface non-intuitive
- Cumbersome data service setup
- No true 3G support
- High price unless (may come with subsidized service bundles)

-- by [Conrad H. Blickenstorfer](#) with technical assistance by [Geoff Walker](#)

[\[go to Neonode website\]](#)